	Benzine.	Blue part of gas flame.	Blue part of petroleum flame.
Beginning of 1st band...	563·2	562·9	—
End	—	537	—
Beginning of 2nd band..	516·4	516·1	515·5 bright line.
		512·5 broad bright line.	512·1 faint band.
End of 2nd band	—	501	—
Beginning of 3rd band...	474·2	473·8	473 very delicate line.
Brightest part	471·2	—	472·5 faint bands.
End	—	464	466·0
		436·8 middle of a band.	437·1 middle of broad faint band.
		430·9 broad line.	430·8 bright line.

From this table it appears that the beginning of the bands of each comet correspond, but that the brightest parts of these vary in position. For comparison with other comets the brightest parts of the bands are given :—

	Comet I., 1871.	Tuttle's Comet.	Encke's Comet.	Coggia's Comet.
1st band	557	557	555	554
2nd band	511	513	512	512
3rd band	—	472	473	469

The remainder of the paper on the change of form consists of daily notes referring to drawings and giving measurements of the comet. The nucleus appears to have changed its shape from round to oval and other forms.—In No. 2,019 Dr. Luther gives an ephemeris for Planet (104) Clymene, which has not been seen since 1868.—Dr. Holetschek and Dr. Luther give position observations of comets and minor planets made last year.—G. W. Hill sends a note on a long period of irregularity of Hestia, arising from the action of the earth, and its application to ascertain the value of the solar parallax.—J. Palisa writes to say that he has discovered Clymene ; he also saw Dione and Althæa again.—Winnecke mentions the discovery, by Borrelly, of a comet, position December 10th : Decl., + 39° 49′·5 ; R.A., 16h. 4m. 65s.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, Jan. 28.—"On the Theory of Ventilation : an attempt to establish a positive basis for the calculation of the amount of fresh air required for an inhabited air-space," by Surgeon-Major F. de. Chaumont, M.D., Assistant Professor of Hygiene, Army Medical School. Communicated by Prof. Parkes, M.D., F.R.S.

In a paper in the *Edinburgh Medical Journal* for May 1867, the author adduced some results to show that the evidence of the senses might be employed (if used with proper care and precautions) as the ground-work of a scale, and gave a short table of the amounts of respiratory impurity (estimated at CO_2) which corresponded to certain conditions noted as affecting the sense of smell.

It is generally admitted that it is organic matter that is the poison in air rendered impure by the products of respiration. It is also admitted that it is the same substance that gives the disagreeable sensation described as "closeness" in an ill-ventilated air-space. Although the nature of the organic matter may vary to a certain extent, it will be allowed that a condition of good ventilation may be established if we dilute the air sufficiently with fresh air, so that the amount of organic matter shall not vary *sensibly* from that of the external air. Observations, however, as far as they have gone, seem to show that the amount of organic impurity bears a fairly regular proportion to the amount of carbonic acid evolved by the inhabitant in an air-space ; and as the latter can be easily and certainly determined, we may take it as a *measure* of the condition of the air-space. If we adopt as our *standard* the point at which there is no sensible difference between the air of an inhabited space and the external air, and agree that this shall be determined by the effects on the sense of *smell*, our next step is to *ascertain* from experiment what is the average amount of CO_2 in such an air-space, from which we can then calculate the amount of air required to keep it in that condition. All the author's results have been obtained in barracks and hospitals.

The plan followed in all was to take the observations chiefly at night, when the rooms or wards were occupied, and when fires and lights (except the lamp or candle used for the observation) were out. On first entering the room from the outer air the sensation was noted and recorded just as it occurred to the observer, such terms as "fresh," "fair," "not close," "close," "very close," "extremely close," &c. being employed. The air was then collected (generally in two jars or bottles, for controlling experiments), and set aside with lime-water for subsequent analysis, and the temperatures of the wet and dry bulb thermometers noted. About the same time samples of the external air were also taken, and the thermometers read. In this way any unintentional bias in the record of sensations was avoided, and this source of fallacy fairly well eliminated.

Although the records of sensation are various in terms, the author has thought that they might be advantageously reduced to *five* orders or classes, each of which he characterises by one or more appropriate terms in common use.

He then proceeds to give an analysis of the results of his observations on the case of each order, from which he draws the following conclusions :—

In order No. 1, "Fresh," &c., a condition of atmosphere not *sensibly* different from the external air, the conditions which are those of *good* ventilation are the following :—

Temperature about 63° Fahrenheit.

Vapour shall not exceed 4·7 grains per cubic foot.

Carbonic acid shall not exceed the amount in the outer air by more than 0·2000 per 1000 volumes.

No. 2.—"Rather close," &c. A condition of atmosphere in which the organic matter begins to be appreciated by the senses, and the ventilation ceases to be *good* :—

Vapour in the air exceeds 4·7 grains per cubic foot.

CO_2 in excess over outer air, ratio reaching 0·4000 per 1000 volumes.

No. 3.—"Close," &c. The point at which the organic matter begins to be decidedly disagreeable to the senses, and the ventilation begins to be decidedly *bad* :—

Vapour reaches 4·9 grains per cubic foot.

Carbonic acid in excess over outer air to the amount of 0·6000 per 1000 volumes.

No. 4.—"Very close," &c. The point at which the organic matter begins to be offensive and oppressive to the senses, and the ventilation *very bad* :—

Vapour reaches 5·00 grains per cubic foot.

Carbonic acid in excess over outer air reaches 0·8000 per 1000 volumes.

No. 5.—"Extremely close," &c. The maximum point of differentiation by the senses :—

Vapour 5·100 grains per cubic foot.

Carbonic acid, in excess over the amount in the outer air beyond, 0·8500 per 1000 volumes.

It will at once be seen that the figures in No. 5 differ but little from those in No. 4, and that the probable *limit of differentiation* by the senses is reached in No. 4. The number of recorded observations in No. 5 is also very few comparatively ; and the author thinks it would therefore be better to group the two together thus :—

Nos. 4 and 5 combined, being the probable limit of possible differentiation by the senses.

1. *Temperature.*—In the outer air 51°·43, in the inhabited air-spaces 65°·12, or a mean difference of 13°·69.

2. *Vapour and Humidity.*—The vapour in the outer air was 3·729, inside 5·108, or a mean difference of 1·379 grain, corresponding to a lowering of relative humidity of 8·92 per cent.

3. *Carbonic Acid.*—In the outer air 0·3928, in the inhabited air-spaces 1·2461, or a mean difference due to respiratory impurity of 0·8533, the range for probable error of result being between 0·8717 and 0·8349.

We may therefore say that when the vapour * reaches 5·100 grains per cubic foot, and the CO_2 in excess 0·8000 volume per 1,000, the maximum point of differentiation by the senses is reached.

The author then shows that there is a regular progression as we pass from one order to another.

He then proceeds to give a large number of tabular statements, calculations, and ratios, his practical conclusion being that the experimental data already quoted fairly justify the adoption of the following

Conditions as the Standard of good Ventilation.

Temperature (dry bulb) 63° to 65° Fahrenheit.

" (wet bulb) 58° to 61° "

* It is to be understood that the amounts of vapour stated in these cases are in reference to a mean temperature of about 63 F.

Vapour ought not to exceed 4°·7 grains per cubic foot at a temperature of 63° F., or 5·0 grains at a temperature of 65° F.

Humidity (per cent.) ought not to exceed 73 to 75.

Carbonic Acid. Respiratory impurity ought not to exceed 0·0002 per foot, or 0·2000 per 1000 volumes.

Taking the mean external air ratio at 0·4000 per 1000, this would give a mean internal air ratio of 0·6000 per 1000 volumes.

Feb. 4.—Remarks on Professor Wyville Thomson's Preliminary Notes on the nature of the Sea-bottom procured by the soundings of H.M.S. *Challenger*, by William B. Carpenter, F.R.S.

The author began by referring to two of the questions started and partly discussed in Professor Wyville Thomson's communication.

The first of these questions is, whether the *Globigerinæ*, by the accumulation of whose shells the *Globigerina* ooze is being formed on the deep-sea bottom, live and multiply on that bottom, or pass their whole lives in the superjacent water (especially in its upper stratum), only subsiding to the bottom when dead.

Prof. Wyville Thomson has been led to adopt the latter opinion, by the results of Mr. Murray's explorations of the surface and sub-surface waters with the tow-net; while the close relation which they further indicate between the surface-fauna of any particular locality and the materials of the organic deposit at the bottom appears to Prof. Wyville Thomson to warrant the conclusion that the latter is altogether derived from the former.

The author, without calling in question the correctness of these observations, submitted, *first*, that they bear a different interpretation; and, *second*, that this interpretation is required by other facts, of which no account seems to have been taken by Prof. Wyville Thomson and his coadjutor. That the *Globigerinæ live on the bottom only*, is a position clearly no longer tenable; but that they live and multiply *in the upper waters only*, and only sink to the bottom after death, seems to the author a position no more tenable than the preceding; and he adduces the evidence which appears to him at present to justify the conclusion that whilst the *Globigerinæ* are pelagic in an earlier stage of their lives, frequenting the upper stratum of the ocean, they sink to the bottom *whilst still living*, in consequence of the increasing thickness of their calcareous shells, and not only continue to *live* on the sea-bed, but probably *multiply* there,—perhaps there exclusively.

That there is no *à priori* improbability in their doing so, is proved by the abundant evidence in the author's possession of the existence of foraminiferal life at abyssal depths obtained during the *Porcupine* expeditions of 1869 and 1870.

Of the existence of living *Globigerinæ* in great numbers in the stratum of water immediately above the bottom, at from 500 to 750 fathoms' depth, the author is able to speak with great positiveness. It several times happened, during the third cruise of the *Porcupine* in 1869, that the water brought up by the water bottle from immediately above the *Globigerina* ooze was quite turbid; and this turbidity was found (by filtration) to depend, not upon the suspension of amorphous particles diffused through the water, but upon the presence of multitudes of young *Globigerinæ*, which were retained upon the filter, the water passing through it quite clear. The contrast in size and condition between the floating shells and those lying on the bottom immediately beneath them was most complete.

The author then alluded to the observations of Dr. Wallich, with which his own are in entire accordance, and which leave no reasonable ground for doubt that the contrast is a consequence of their continued *life*. For it is clearly shown, by making thin transparent sections of the thick-shelled *Globigerinæ*, that the change of external aspect is due to the remarkable *exogenous deposit* which is formed, after the full growth of the *Globigerina* has been attained, upon the outside of the proper chamber-wall. This deposit is not only many times thicker than the original chamber-wall, but it often contains flask-shaped cavities opening from the exterior, and containing sarcode prolonged into it from the sarcodic investment of the shell. From these important observations, it seems to the author an almost inevitable inference that the subsidence of the *Globigerinæ* to the bottom is the consequence, not of their death, but of the increasing thickness and weight of their shells, produced by living action.

That the *Globigerinæ* which have subsided to the bottom continue to live there is further indicated by the condition of the sarcodic contents of their shells. In any sample of *Globigerina* ooze that the author has seen brought up by the dredge or the sounding apparatus, part of the shells (presumably those of the surface-layer) were filled with a sarcode-body corresponding in condition with that of foraminifera known to live on the sea-bed, and retaining the characteristic form of the organism after the removal of the shell by dilute acid. In the same sample will be found shells distinguishable from the preceding by their dingy look and greyish colour, by the want of consistence and viscidity in their sarcode contents, and by the absence of any external sarcodic investment; these are presumably dead. Other shells, again, are entirely empty; and even when the surface stratum is formed of perfect *Globigerinæ*, the character of the deposit soon changes as it is traced downwards. (See "Depths of the Sea," p. 410). These facts seem to the author to mark very strongly the distinction between the *living* surface-layer and the *dead* sub-surface layer; and to show that there is nothing in the condition of the deep sea that is likely to prevent or even to retard the decomposition of the dead sarcode bodies of *Globigerinæ*. There is a significant indication of the undecomposed condition of the sarcode bodies of the *Globigerinæ* of the surface-layer, in the fact that they serve as food to various higher animals which live on the same bottom.

It seems to the author clear, from the foregoing facts, that the *onus probandi* rests on those who maintain that the *Globigerinæ* do *not* live on the bottom; and such proof is altogether wanting. The most cogent evidence in favour of that proposition would be furnished by the capture, floating in the upper waters, of the large thick-shelled specimens which are at present only known as having been brought up from the sea-bed. And the capture of such specimens would only prove that even in this condition the *Globigerinæ* can float; it would not show that they cannot also live on the bottom.

That the *Globigerinæ* not only *live*, but *propagate*, on the sea-bottom, is indicated by the presence (as already stated) of enormous multitudes of very young specimens in the water immediately overlying it. And thus all we at present know of the life-history of this most important type seems to lead to the conclusion, that whilst in the earlier stages of their existence they are inhabitants of the upper waters, they sink to the bottom on reaching adult age, in consequence of the increasing thickness of their shells, that they propagate there (whether by gemmation or sexual generation is not known), and that the young, rising to the surface, repeat the same history.

The author then proceeded to show that the relation between the surface-fauna and the bottom-deposit is by no means as constant as Prof. Wyville Thomson and Mr. Murray affirm it to be.

It may be taken as proved that there is no want of foraminiferal life in the Mediterranean. To confirm this the author referred to the results obtained by various observers. That Foraminifera, especially *Globigerinæ*, abound in its surface-water at Messina, is testified by Hæckel in the passage cited by Prof. Wyville Thomson; and when it is considered how large an influx of Atlantic water is constantly entering through the Strait of Gibraltar, and is being diffused throughout the Mediterranean basin, and how favourable is its temperature-condition, it can scarcely be doubted that if the doctrine now upheld by Prof. Wyville Thomson were correct, the deposit of *Globigerina* shells over the whole bottom-area ought to be as abundant as it is in the Atlantic under corresponding latitudes. Yet the author found the deeper bottoms, from 300 fathoms downwards, entirely destitute of Globigerinæ as of higher forms of animal life; and this was also the experience of Oscar Schmidt.

The author can see no other way of accounting for the absence of *Globigerina* ooze from the bottom of the Mediterranean, save on its shallow borders, than by attributing it to the unfavourable nature of the influences affecting the *bottom-life* of this basin; that is to say, the gradual settling down of the fine sedimentary deposit which forms the layer of inorganic mud everywhere spread over its deeper bottom; and the deficiency of oxygen and excess of carbonic acid which the author has shown to prevail in its abyssal waters, giving them the character of a stagnant pool; these influences acting either singly or in combination.

Another fact to which Prof. Wyville Thomson formerly attached considerable importance as indicative of the bottom-life of the *Globigerinæ*, is unnoticed in his recent communication, viz., the singular limitation of the *Globigerina* ooze to the "warm area" of the sea-bed between the North of Scotland and the Faroe Islands. Details of the observation will be found in the author's *Lightning* and *Porcupine* Reports on the exploration of this region. On the "cold area" the author never found a single *Globigerina*; the bottom consisting of sand and gravel, and the Foraminifera brought up from it being almost exclusively those

which form arenaceous tests. The "warm area," on the other hand, is covered with *Globigerina* ooze to an unknown depth; its surface stratum being composed of perfect shells filled with sarcode, whilst its deeper layers are amorphous. Near the junction of the two areas, but still within the thermal limit of the "warm," sand and *Globigerina* ooze are mingled; this being peculiarly noticeable on the "*Holtenia* ground," which yielded a large proportion of our most noteworthy captures in this locality. Now, if the bottom-deposit is dependent on the life of the surface-stratum, why should there be this complete absence of *Globigerina* ooze over the "cold area," the condition of the surface-stratum being everywhere the same? The author can see no other way of accounting for it than by attributing it to the drift of the cold underflow carrying away the *Globigerinæ* that are subsiding through it, towards the deep basin of the Atlantic, into which he believes that underflow to discharge itself. Prof. Wyville Thomson, however, denies any sensible movement to this underflow, continuing to speak of it as "banked up" by the Gulf Stream,* which here (according to him) has a depth of 700 fathoms; and this very striking example of want of conformity between the surface-fauna and the bottom-deposit consequently remains to be accounted for on his hypothesis.

The other of Prof. Wyville Thomson's principal conclusions relates to the origin of the "red clay," which he found covering large areas in the Atlantic, and met with also between Kerguelen's Land and Melbourne. Into this red clay he describes the *Globigerina* ooze as graduating through the "grey ooze;" and he affirms this transition to be essentially dependent on the depth of the bottom. And from the data which he gives he considers it an indubitable inference "that the red clay is essentially the insoluble residue, the *ash*, as it were, of the calcareous organisms which form the *Globigerina* ooze after the calcareous matter has been by some means removed." This inference he considers to have been confirmed by the analysis of several samples of *Globigerina* ooze, "always with the result that a small proportion of a red sediment remains, which possesses all the characters of the red clay." Prof. Wyville Thomson further suggests that the removal of the calcareous matter may be due to the presence of an excess of carbonic acid in the bottom waters, and to the derivation of this water in great part from circumpolar freshwater ice, so that, being comparatively free from carbonate of lime, its solvent power for that substance is greater than that of the superjacent waters of the ocean. He might have added probability to his hypothesis, if he had cited the observations of Mr. Sorby as to the increase of solvent power for carbonate of lime possessed by water under greatly augmented pressure.†

The author, however, after a careful examination of the data given by Prof. Wyville Thomson, thinks it is clear that no constant relation exists betweeen depth and the nature of the bottom.

The author agrees with Prof. Wyville Thomson in thinking that the remarkable uniformity of the "red clay" deposit, coupled with its peculiar composition, indicates that it is not derived from the land; and the author's suggestion is based on its near relation in composition, notwithstanding its great difference in appearance, to *Glauconite*—the mineral of which the greensands that occur in various geological formations are for the most part composed, and which is a silicate of peroxide of iron and alumina.

It is well known that Prof. Ehrenberg, in 1853,‡ drew attention to the fact that the grains of these green sands are for the most part, if not entirely, *internal casts* of Foraminifera; the sarcodic bodies of the animals having been replaced by glauconite, and the calcareous shells subsequently got rid of, either by abrasion, or by some solvent which does not attack their contents. It was soon afterwards shown by Prof. Bailey (U.S.), that in certain localities a like replacement is going on at the present time, the chambers of recent Foraminifera being occasionally found to be occupied by mineral deposit, which, when the shell has been dissolved away by dilute acid, presents a perfect internal cast of its cavities. The author then referred in this connection to the researches of Messrs. Parker and Rupert Jones on Mr. Beete Jukes's Australian dredgings, and to his own on a portion of the foraminiferal sand dredged by Capt. Spratt in the Ægean (kindly placed in his hands by Mr. J. Gwyn Jeffreys).

* See his "Depths of the Sea," p. 400.
† Proceedings of the Royal Society, 1862-63, p. 538.
‡ "Ueber den Grünsand und seine Erlauterung des organischen Lebens," in Abhandl. der Königl. Acad. der Wissensch. zu Berlin, 1855, p. 85.

The author said that alike in Mr. Jukes's and in Capt. Spratt's dredgings, some of these casts are in *green* silicates, and some in *ochreous*, corresponding precisely to the two kinds of fossil casts described by Prof. Ehrenberg.

The author, in the residue left after the decalcification of Capt. Spratt's dredgings, noticed a number of small particles of *red clay*, some of them presenting no definite shape, whilst others approximated sufficiently closely in form and size to the green and ochreous "internal casts" to induce him to surmise that these also had been originally deposited in the chambers of Foraminifera, their material being probably very nearly the same, although its state of aggregation is different. And if this was their real origin, he would be disposed to extend the same view to the red clay of the *Challenger* soundings.

In conclusion, the author submitted that if the red clay is (as he is disposed to believe) a derivation of the *Globigerina* ooze, its production is more probably due to a *post-mortem* deposit in the chambers of the Foraminifera than to the appropriation of its material by the living animals in the formation of their shells. That deposit may have had the character, in the first instance, of either the green or the ochreous silicate of alumina and iron, which constitutes the material of the internal casts; and may have been subsequently changed in its character by a metamorphic action analogous to that which changes felspar into clay. The presence of an excess of carbonic acid would have an important share in such a metamorphosis, and the same agency (especially when operating under great pressure) would be fully competent to effect the removal of the calcareous shells. This seems to the author the most probable mode of accounting for their disappearance from a deep-sea deposit, where no mechanical cause can be invoked. But in shallower waters, where the same excess of carbonic acid does not exist, and the aid of pressure is wanting, but where a movement of water over the bottom is produced by tides and currents, he is disposed rather to attribute the disappearance of the shells to mechanical abrasion. This is the explanation the author would be disposed to give of the disappearance of the shells from the green sand brought up by the *Challenger* in the course of the Agulhas Current; but whether it was mechanical abrasion or chemical solution that removed the foraminiferal shells whose internal casts formed the Greensand deposit of the Cretaceous epoch, must remain for the present an open question.

Linnean Society, Feb. 4.—Dr. G. J. Allman, F.R.S., president, in the chair.—Capt. Gilbert Mair and Dr. Llewellyn Powell were elected Fellows.—The following papers were read:—On *Arisæna speciosum*, by Mr. J. Gammie. The remarkable appendage to the spadix of this plant had been supposed to be connected with a contrivance to favour cross-fertilisation, but the author had been unable to find that it is visited by insects.—On the Algæ of Simon's Bay.—On the Fungi collected during the *Challenger* Expedition, by the Rev. M. J. Berkeley.—On the plants and insects of Kerguelen's Land, by Mr. H. N. Moseley. The author enumerated the insects met with during the visit of the party, including only one winged gnat, all the rest being apterous. A great quantity of one species were seen crawling over the *Pringlea*, but not on the infloresence.—On the origin and prevailing systems of phyllotaxis, by the Rev. G. Henslow. In this elaborate paper the object of the author appeared to be to trace all existing systems of phyllotaxis to modifications of the decussate as the simplest.—A discussion followed, in which Mr. Hiern, Prof. Dyer, Mr. A. W. Bennett, and Dr. Masters took part.

Zoological Society, Feb. 2.—Dr. A. Günther, F.R.S., vice-president, in the chair.—Mr. Sclater exhibited and made remarks on a fine skin and skull of a female Huemul (*Cervus chilensis*), and a pair of horns of an adult male of the same animal, forwarded by Mr. Edwyn C. Reed, of the National Museum, Santiago, Chili.—Dr. E. Hamilton exhibited and made remarks on some deformed sterna of the common fowl.—Prof. A. H. Garrod read a paper on the kangaroo called *Halmaturus luctuosus* by D'Albertis, and on its affinities, in which such points in the anatomy of the type-specimen were described as served to explain its systematic position. It was shown from the form of the premolar and molar teeth, from the nature of the fur, and from other minor details, that this species must be placed in the same genus as the *Dorcopsis brunii* (Müller), named more correctly *D. muelleri* (Schlegel). The species, therefore, should stand as *Dorcopsis luctuosa*, being the only other known species of the genus. It was also shown that *Dorcopsis*, together with *Dendro-*

lagus, form a well-marked independent group of the Macropoid Marsupialia.—Mr. Sclater read notices of some rare parrots now living in the Society's Gardens, and called special attention to examples of Goffin's Cockatoo (*Cacatua goffini*), and Bouquet's Parrot (*Chrysotis bouqueti*), as being amongst the rarest specimens.—A communication was read from Mr. Edward Bartlett, curator of the Museum and Public Library, Maidstone, containing a list of the mammals and birds collected by Mr. Waters in Madagascar, amongst which was a fine adult specimen of the Madagascar River-hog (*Potamochœrus edwardsi*).—A communication was read from Mr. E. P. Ramsay, containing remarks on the original skin of *Ptilonorhynchus rawnsleyi*, which he regarded as a hybrid between the Satin Bower-bird (*Ptilonorhynchus holosericeus*) and the Regent-bird (*Sericulus chrysocephalus*).—Mr. R. Bowdler Sharpe read a paper entitled "Contributions to the Ornithology of Madagascar," being the fourth communication on the same subject made to the Society. This paper contained descriptions of a new Accipitrine form proposed to be called *Eutriorchis astur*, a new species of *Atelornis*, proposed to be called *A. crossleyi*, and a new form of Nectariniidæ, to which the name *Neodrepanis coruscans* was assigned.—Dr. Günther, F.R.S., read a paper on some mammals recently collected by Mr. Crossley in Madagascar, amongst which were a new Lemur, proposed to be called *Chirogaleus trichotis*, and a new form of rodent, belonging to the Muridæ, for which the name *Brachytarsomys albicauda* was suggested.

Geological Society, Jan. 7.—Mr. John Evans, F.R.S., president, in the chair.—The following communications were read:—On the structure and age of Arthur's Seat, Edinburgh, by Mr. John W. Judd. The author said that Arthur's Seat, so long the battle-ground of rival theorists, furnished in the hands of Charles Maclaren a beautiful illustration of the identity between the agencies at work during past geological periods and those in operation at the present day. One portion, however, of Maclaren's masterly exposition of the structure of Arthur's Seat, that which requires a *second* period of eruption upon the same site, but subsequent to the deposition, the upheaval and the denudation of the whole of the Carboniferous rocks, is beset with the gravest difficulties. The Tertiary and Secondary epochs have in turn been proposed and abandoned as the period of this supposed second period of eruption; and it has more recently been placed, on very questionable grounds, in the Permian. The antecedent improbabilities of this hypothesis of a second period of eruption are so great, that it was abandoned by its author himself before his death. A careful study of the whole question by the aid of the light thrown upon it in comparing the structure of Arthur's Seat with that of many other volcanoes, new and old, shows the hypothesis to be alike untenable and unnecessary. The supposed proofs of a second period of eruption, drawn from the position of the central lava column, the nature and relations of the fragmentary materials in the upper and lower parts of the hill respectively, and the position of certain rocks in the Lion's Haunch, all break down on re-examination. While, on the other hand, an examination of Arthur's Seat, in connection with the contemporaneous volcanic rocks of Forfar, Fife, and the Lothians, shows that in the former we have the relics of a volcano which was at first submarine but gradually rose above the Carboniferous sea, and was the product of *a single* and almost continuous series of eruptions.—"The Glaciation of the Southern Part of the Lake-district, and the Glacial Origin of the Lake-basins of Cumberland and Westmoreland" (second paper), by Mr. J. Clifton Ward. The directions of ice-scratches in the various dales having been pointed out, the course of the several main glaciers was described, and it was shown how they must have become confluent in all the lower ground, forming a more or less continuous ice-sheet, which overlapped most of the minor ridges parting valley from valley, and was frequently forced diagonally across them. The positions of certain ice-grooves having an abnormal direction were described; in several cases these cross lofty ridges at right angles to their direction, and generally at passes or depressions along a water-shedding line. Most of those noticed had a generally east and west direction, and occurred at varying heights, from 1,250 to 2,400 feet. The author, while acknowledging the difficulty attendant upon *any* explanation, was inclined, though somewhat doubtfully, to regard these abnormal markings as due to floating ice, during the great period of interglacial submergence. The moraines were all believed to belong to the last set of glaciers. The subject of the "Glacial origin of Lake-basins" was then entered upon, and the following lakes discussed by means of diagrams drawn to scale, showing lake-depths, mountain outlines, and the thickness of the ice:—Wastwater, Grasmere, Easdale, Windermere, Coniston, and Esthwaite, together with several mountain tarns. In the case of Wastwater, the bottom was shown to run below the level of the sea for a distance of a mile and a quarter, and the deepest point to be just opposite the spot at which the only side valley joins the main one. While the greatest depth of the lake is 251 feet, the thickness of the old glacier-ice must have been fully 1,500; and, all points considered, Prof. Ramsay's theory of glacial erosion seemed to the author certainly to be upheld. In like manner, the same theory was thought to account for the origin of the other lakes mentioned, such ones as Windermere and Coniston being but long narrow grooves formed at the bottom of pre-existing valleys. Mountain tarns were held to be due sometimes wholly to glacial erosion, sometimes to this combined with a moraine dam, and occasionally to the ponding back of water by moraines alone, or moraine-like mounds formed at the foot of snow-slopes.

Chemical Society, Feb. 4.—Prof. Odling, F.R.S., in the chair.—A communication from Mr. G. Whewell, entitled "Test for Carbolic Acid," and a note on the action of anhydrous ether on titanic tetrachloride, by Mr. P. P. Benson, were read. Two crystalline compounds are obtained in this reaction: the one, boiling at 105° to 120° C., and melting at 42° to 48° C., has the composition $TiCl_4$ (C_4H_{10}) O; the other, titanium ethyl trichlorhydrine, $TiCl_3$ (C_2H_5O), melts at 76° to 78° C., and boils at 186° to 188° C.—The last paper was by Mr. W. H. Perkins, F.R.S., on dibromacetic and glyoxylic acids.

Institution of Civil Engineers, Feb. 2.—Mr. Thos. E. Harrison, president, in the chair.—The paper read was "On the origin of the Chesil Bank, and on the relation of the existing beaches to past geological changes, independent of the present coast action," by Prof. Joseph Prestwich, F.R.S., &c.—This remarkable bank of pebbles, extending from Portland to Abbotsbury, a distance of nearly eleven miles, was described with great accuracy by Sir John Coode, M. Inst. C.E., in 1853 (*vide* "Minutes of Proceedings Inst. C.E.," vol. xii. p. 520). It was then 43 feet high and 600 feet wide at the south end, decreasing to 23 feet high and 510 feet wide at the north end. The pebbles diminished in size from Portland to Abbotsbury. Sir John Coode also stated that the shingle consisted chiefly of pepples of chalk-flint, with a small proportion of others of red sandstone, porphyry, and jasper, none of which could have been derived from local rocks. In order to determine their origin, he examined the coast from Portland to Start Point, and traced the flints to the chalk cliffs between Axmouth and Lyme, and the red sandstone, porphyry, and jasper pebbles to the new red sandstone of Budleigh Salterton and other places in Devonshire; whence he concluded that the only source from which the shingle of the Chesil Bank could have been derived was between Lyme Regis and Budleigh, and that it was propelled eastward along the coast to the Chesil Bank by the action of wind-waves, due to the prevalent and heaviest seas. The objection to this view urged at the time by the Astronomer Royal was, that the largest shingle occurred at the Portland end of the beach, or the most distant part from which it had travelled. More recently an old "raised beach," standing from twenty-one to forty-seven feet above the present beach, had been discovered on the Bill of Portland, and Prof. Prestwich showed that this beach contained all the materials found in the Chesil Bank, including also numerous chert pebbles from the Upper Greensand of the cliff between Bridport and Sidmouth. This raised beach was not due to any existing agency, but to causes in operation at a geological period so remote as the end of the glacial period, and before the land had assumed its present position and shape. Remnants of this beach could be found in or on the present cliffs, at intervals from Brighton to the coast of Cornwall, being more numerous in Devon and Cornwall, as the rocks were harder, than among the softer strata of Dorset and Hants, where, with few exeptions, the old line of cliff had been worn back and deeper bays formed. The travel of the shingle of this old beach was generally like that of the present beach, from west to east. The author considered that the action of the "Race" off Portland, and of the tidal waves during storms, combined to drive the shingle of the old beach at the Bill, and of that portion of it which must be spread on the sea-bed westward of Portland, on to the south end of the Chesil Bank, whence the shingle was driven northward to Abbotsbury and Burton, by the action of the wind-waves, having their maximum force from the S.S.W., a direction which he showed to be the mean of the prevalent winds. Here these wind-waves became parallel with

the coast, and the westward movement ceased about Bridport, beyond which point the shingle travelled in the opposite direction, viz., from west to east, or from the coast of Devon to that of Dorset; the quartzite pebbles from the conglomerate beds of Budleigh Salterton, which travelled from that part of the coast eastward to and beyond Sidmouth, gradually diminishing in numbers as they approached Lyme, very few, if any, reaching Bridport. This conclusion was in accordance with the facts—(1) That the pebbles of the Devonshire and Dorset strata, which formed the shingle of the "raised beach," constituted also the bulk of the Chesil Bank; (2) That there were also, in that bank, pebbles of the rocks and flint of Portland itself; (3) That the largest pebbles occurred at the Portland end of the bank, the pebbles decreasing gradually in size to Abbotsbury. The large dimensions of the bank he attributed to the great accumulative and small lateral action of the waves. Prof. Prestwich next discussed the questions connected with the shingle of the south coast generally, and showed that the greater part of it was derived indirectly from beds of quaternary gravel and débris, from the wreck of the "raised beach," and partly from the strata of the chalk and other cliffs, and not altogether or directly from the present cliffs. He noticed, also, the westward movement of the shingle from Lulworth towards Weymouth, owing to the interference of the Isle of Portland with the force of the S.S.W. wind-waves, and considered that none of the Devon and West Dorset shingle beach now passed the Bill of Portland, and that other such breaks might exist to the eastward whenever similar conditions were repeated. He explained the origin of the Fleet, like that of the Weymouth backwater, and of the Lodmore Marshes, by the growth of the Chesil Bank on the one hand, and of the Ringstead and Weymouth Beach on the other, gradually damming in portions of the old coast line. Those beaches themselves travelled on a line along which the opposing forces of the wind-waves and tidal currents and the inertia of the mass to be moved were balanced. These views were stated to be in conformity with the theoretical opinion expressed on abstract grounds by the Astronomer Royal, and with the experience of practical persons residing on the spot. The paper was illustrated by sections and diagrams, showing the position and range of the "raised beach" along the coasts of Dorset and Devonshire.

Royal Microscopical Society, February 3.—Anniversary Meeting.—Mr. Charles Brooke, president, in the chair.—The Annual Report of the Council was submitted, and showed that the library, cabinet, and instruments were in a satisfactory condition; that seventeen new fellows, one honorary fellow, and one corresponding fellow had been elected during the year, and that ten had been removed by death.—The President read the annual address.—The result of the ballot for officers and Council for the ensuing year was as follows:—President, Mr. C. H. Sorby. Vice-Presidents: Dr. Robert Braithwaite, Mr. Chas. Brooke, Dr. J. Millar, and Dr. W. B. Carpenter. Treasurer, Mr. John W. Stephenson. Hon. Secs., Messrs. H. J. Slack and Charles Stewart. Council: Messrs. Frank Crisp, J. E. Inkpen, S. J. M'Intire, Henry Lee, W. T. Loy, Dr. Lawson, Dr. J. Matthews, Messrs. George Shadbolt, Chas. Tyler, F. H. Ward, F. H. Wenham, and Chas. F. White. Assist. Sec., Walter W. Reeves.

PARIS

Academy of Sciences, Feb. 1.—M. M. Frémy in the chair.—The following papers were read:—On the physico-chemical forces and their intervention in the production of natural phenomena, by M. Becquerel.—A note by M. Yvon Villarceau, relating to the discussion of the observations of the transit of Venus.—M. Leverrier then presented to the Academy a new part of the "*Atlas écliptique de l'Observatoire de Paris.*" This atlas represents a circular zone of 5 degrees breadth ($2\frac{1}{2}°$ each side of the ecliptic), and on each map contains a space of 20 min. of R.A. Seventy-two maps will thus complete it, but it will doubtless contain several more for the vicinity of the equinoxes; all stars visible in a telescope of 24 centimetres aperture (about $9\frac{1}{2}$ in.), down to the 13th magnitude inclusive, will be carefully mapped in it. Four plates of the new part just published are by MM. Paul and Prosper Henry, and contain 7,655 stars.—M. Leverrier then made some remarks on the results of the observations of the transit of Venus.—The Academy elected as candidates for the chair of Natural History of Inorganic Bodies, at the Collège de France, rendered vacant by the death of M. Elie de Beaumont, in the first place, M. Ch. St. Claire-Deville, and in the second, M. Fouqué.—The remaining papers read were the following:—On an "anallatic" telescope and its application to a levelling compass and a "tacheomèter," by M. C. M. Goulier.—On the general theory of percussions and the manner to apply it in the calculation of the effect of shots, and the different parts of the gun-carriages, by M. H. Putz.—A note on magnetism, by M. J. M. Gaugain. Another one on the same subject, by M. A. Trève.—On the magnetic anomaly of peroxide of iron prepared from meteoric iron, by M. L. Smith.—On the artificial reproduction of monazite and xenotime, by M. F. Radominski; these minerals are the very rare phosphates of cerium, lanthanum, and didymium.—On the pulverisation of manures and the best means to increase the fertility of soils, by M. Menier.—A note by M. H. Tarry, on the possibility of predicting for some days in advance the arrival in Europe of cyclones, which cross the Atlantic; these remarks were based on the fact that M. Tarry received telegrams on Jan. 11th from Boston and St. Pierre Miquelon, stating that a great cyclone had its centre in Newfoundland on Jan. 10th, and was taking its course eastward—that it was calculated to arrive in Europe by way of Ireland in four or five days. The cyclone actually reached Ireland on Jan. 15th, and progressed in an easterly direction for several days after.—MM. J. B. Schnetzler, Rohart, and Le Breton made some communications on Phylloxera.—On "viridic" acid, by M. C. O. Cech.—On a case of recovery from aneurism of the right external carotid artery through digital pressure, by M. J. A. Marques.—On the analysis and classification of cements, by M. Ducournau.—A note by M. Bonnet, on aërial locomotion.—A memoir by M. Maillard, on the treatment of cholera.—M. Gruey communicated the provisional elements of Comet VI., 1874, Borrelly.—M. Stéphan transmitted an account of new observations of the comets of Encke and Winnecke.—M. Genocchi made some observations regarding M. Darboux' paper on the existence of the integral in equations with partial derivatives, containing any number of functions and independent variables.—M. Darboux made a communication on the same subject.—On hydrogenated iron, by M. L. Cailletet; account of experiments made by the author, showing that iron will absorb on the average 240 times its own volume of hydrogen, but after heating will not again absorb hydrogen, as Graham showed to be the case with palladium; the experiments gave results in accordance with those obtained by St. Claire-Deville, Troost, and Hautefeuille, in their researches on the passage of hydrogen through homogeneous bodies, and the compounds of hydrogen with alkaline metals.—On the molecular equilibrium of a solution of chrome alum, by M. Lecoq de Boisbaudran.—On perbromide of bromo-acetylene, by M. E. Bourgoin.—On the improvements in the quality of beetroot, by M. Ch. Viollette.—On a special butyric fermentation, by M. P. Schützenberger.—On the dilating action exercised by the glosso-pharyngian nerve on the vessels of the mucous membrane at the base of the tongue, by M. A. Vulpian.—On a new historical document relating to Salomon de Caus, by M. G. Depping.—A note by M. Neyreneuf, on the combustion of explosive mixtures.—A note by M. J. Kordon, on the composition and distribution of printing type.

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